Explore new perspectives

ESTECO

Ottimizzazione industriale, ESTECO: ottimizzazione e prototipazione virtuale di scambiatori di calore

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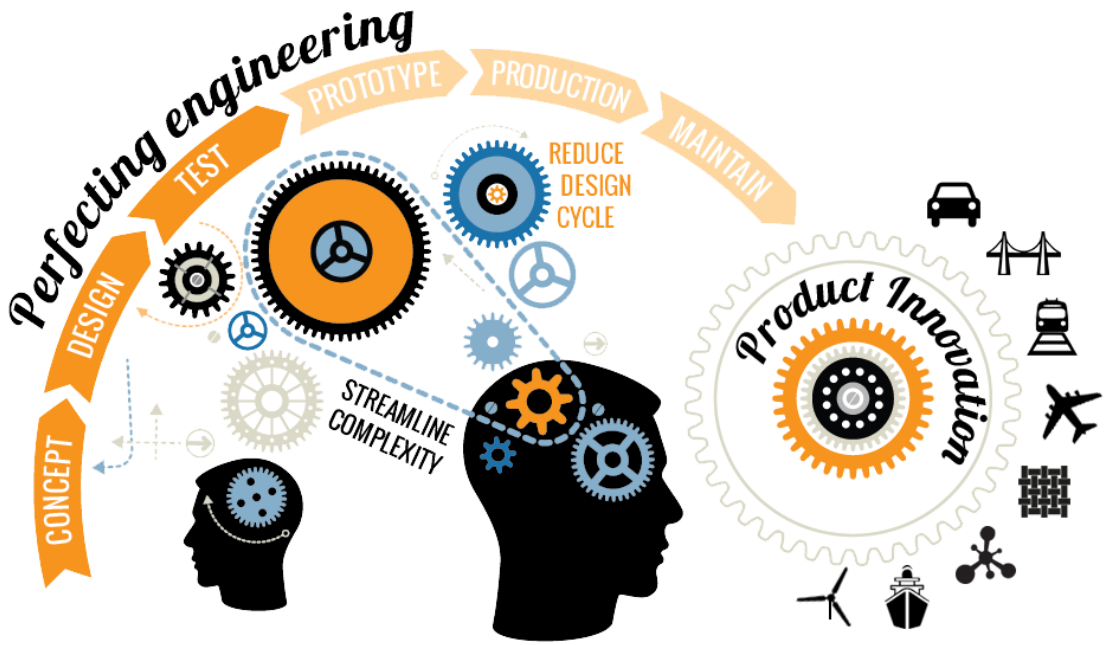
Summary

- Introduction about ESTECO
- modeFRONTIER optimization software
- Optimhex project: virtual platform for heat exchangers optimization design

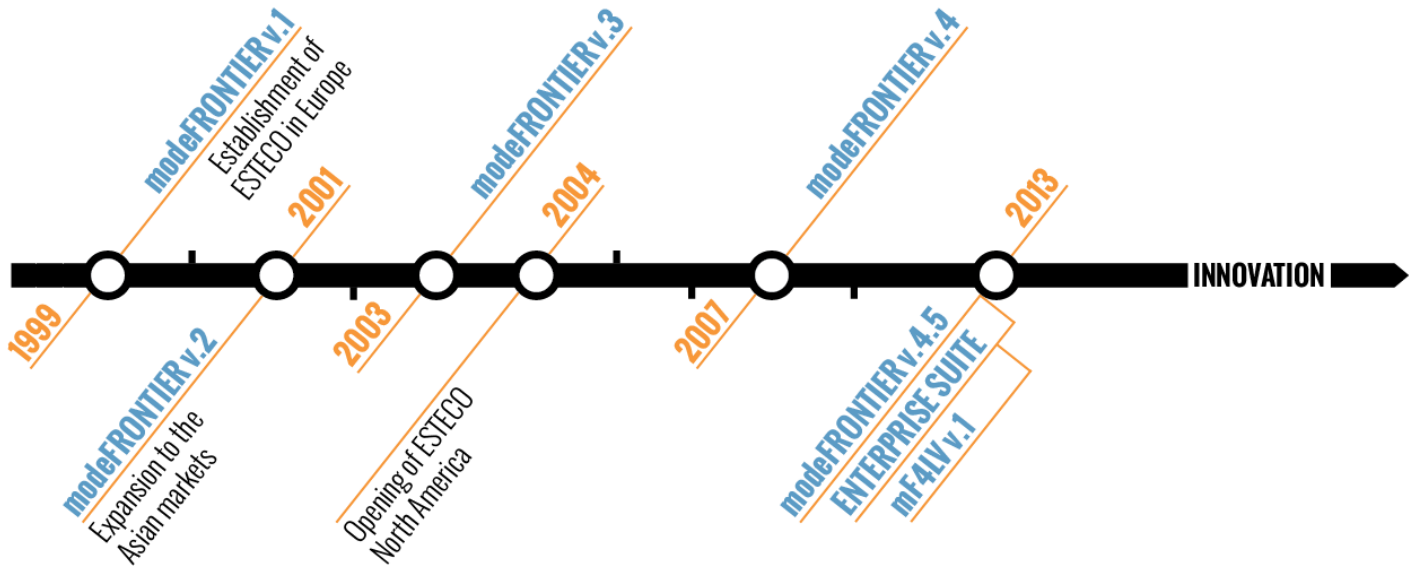
About ESTECO

- ESTECO is a pioneer in **numerical optimization solutions**, specialized in research and development of **engineering software** for all stages of the **simulation-driven design process**.

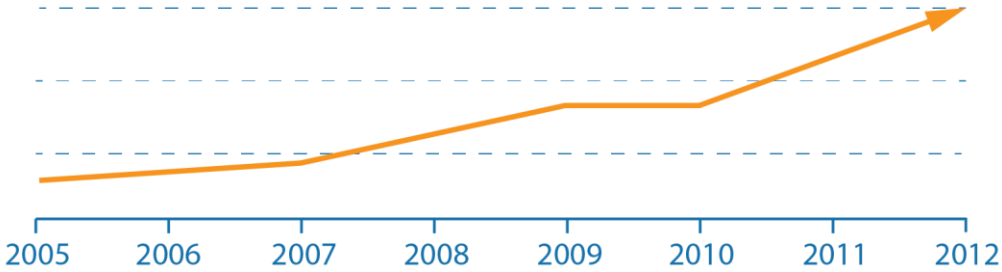


Our History

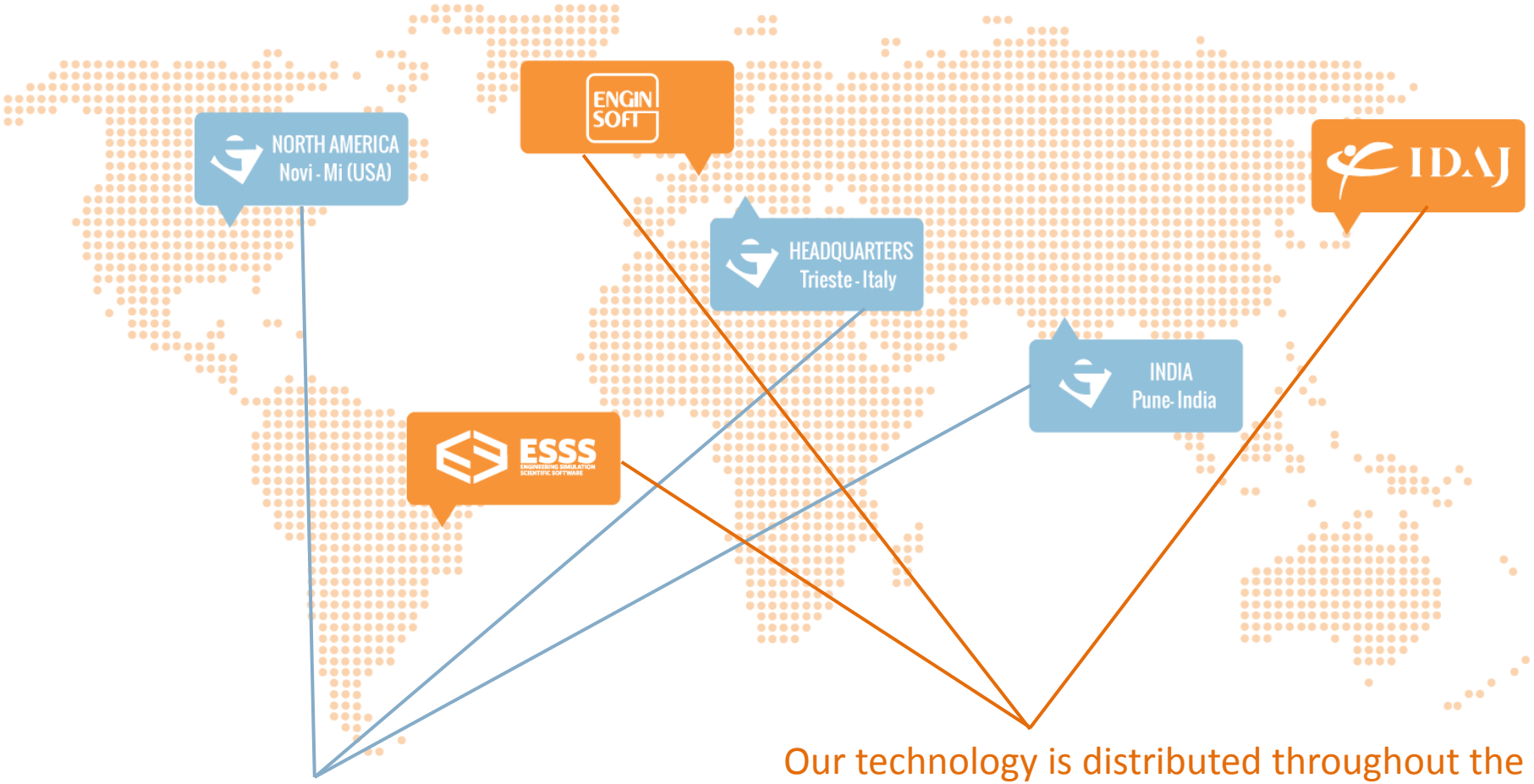
Esteco was born as an University **spin-off company,** turning the knowledge acquired during a European Union funded project on design optimization into a successful commercial product.



The corporate turnover continues to grow and ESTECO keeps on investing in research and development.



Where we are



The company headquarters are located in Trieste, Italy with offices in North America and India

Our technology is distributed throughout the world by a network of qualified channel partners, who provide proficient local service and support to our customers.

ESTECO Alliances

ESTECO has established a **strong network** of first-class partnerships with independent software and hardware vendors. Our belief is that cooperation is essential to effectively **respond to the customers' needs**.

ESTECO clients

Over **300 international clients** have relied on our software to design better and more efficient products across a **wide spectrum of industrial sectors**.

Petrobras

Whirlpool

Embraer

Honda

Polestar Racing

Sony

Bombardier

Nissan

Yamaha

Modine

Piaggio

Mitsubishi Electric Corporation

Ariston

Fujitsu Laboratories

Kawasaki

Mazda

Jaguar Land Rover

FCA

Toyota

Volvo

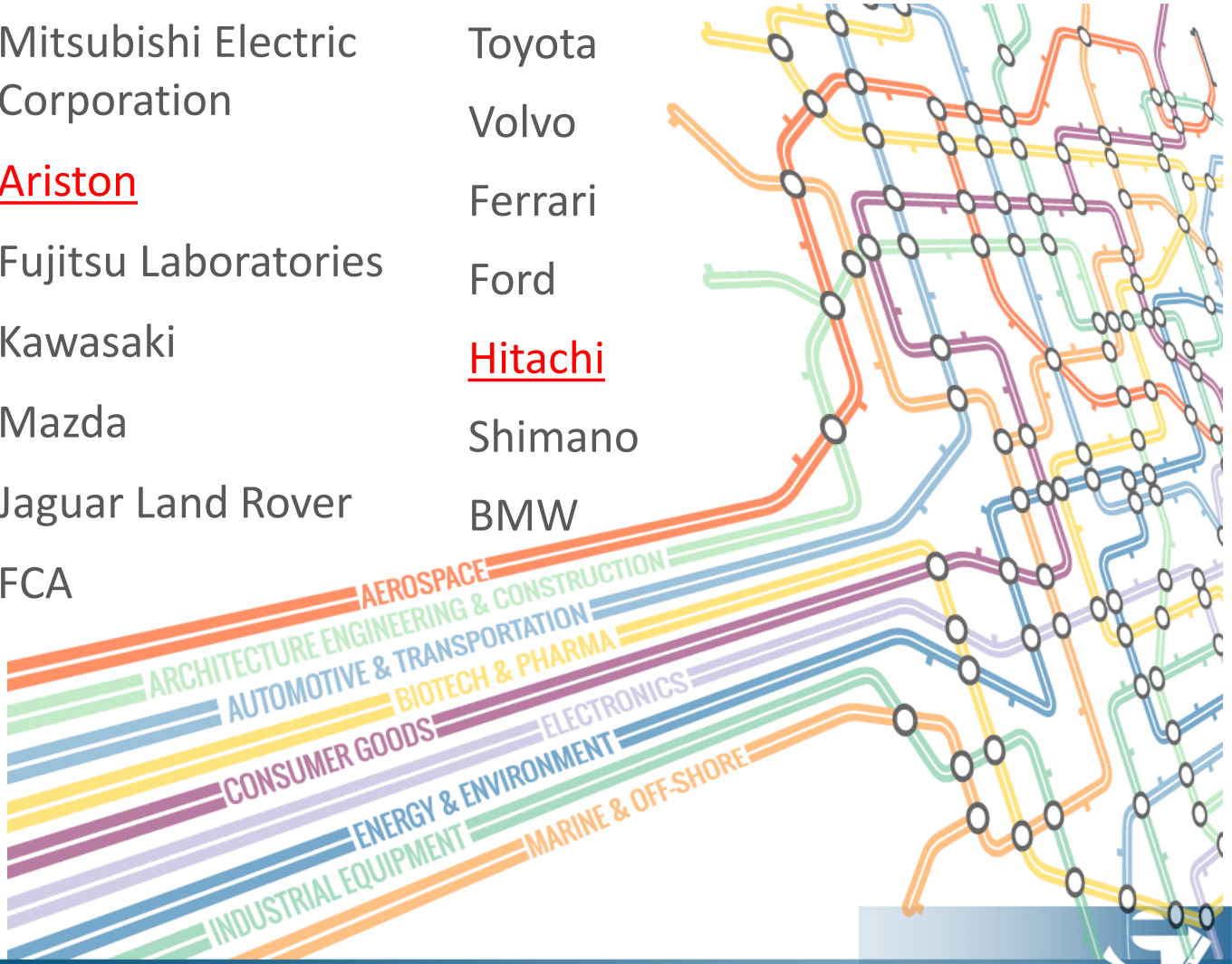
Ferrari

Ford

Hitachi

Shimano

BMW



Research and Academia

ESTECO has established a close relationship with over **200 prestigious research institutes and universities worldwide**

Cranfield University

Chalmers University of Technology

Lund Institute of Technology

CIRA

Osaka University

Università di Trieste

Columbia University

Massachussets Institute of Technology

Tokyo Metropolitan University

ENSAM

DLR - German Aerospace Center

Tohoku University

Beijing University

University of Michigan

Yokohama Technical University

INRIA

Saint-Gobain Recherche

ENSTA ParisTech

Università di Padova

Georgia Institute of Technology

Politecnico di Milano

Lund Institute of Technology

modeFRONTIER Users' Meetings

500+ participants

from **48** countries around the world

150+ speakers

from the most innovative and creative companies and research institutions including BMW, BOMBARDIER, Ferrari, Honda, Motorola, Volvo and many more…

5 International + 3 North American

NOVEMBER 4TH-5TH, 2015
MODEFRONTIER NORTH AMERICA UM 2015 (DETROIT/NOVI, MI)

MAY 17TH-18TH, 2016
MODEFRONTIER INTERNATIONAL UM 2016 (TRIESTE, IT)

Clients say about our technology

Achieved **3% reduction** of fuel consumption

EMBRAER

Drag performance of **olympic K1** rudder was enhanced by **13%**

CONI - FERRARI

Aerodynamic perfomance enhaced by **2.5%** with a **4%** wing **weight reduction**

Alenia Aermacchi

20% less aerodynamic drag reduced **energy** consumption by **10%**

BOMBARDIER

Auto correlation on **airbags** experimental tests **from 6 weeks to 2 hours**

JAGUAR – LAND ROVER

50.000 vs 50 design configurations verified in the **same time**

PIAGGIO &C.

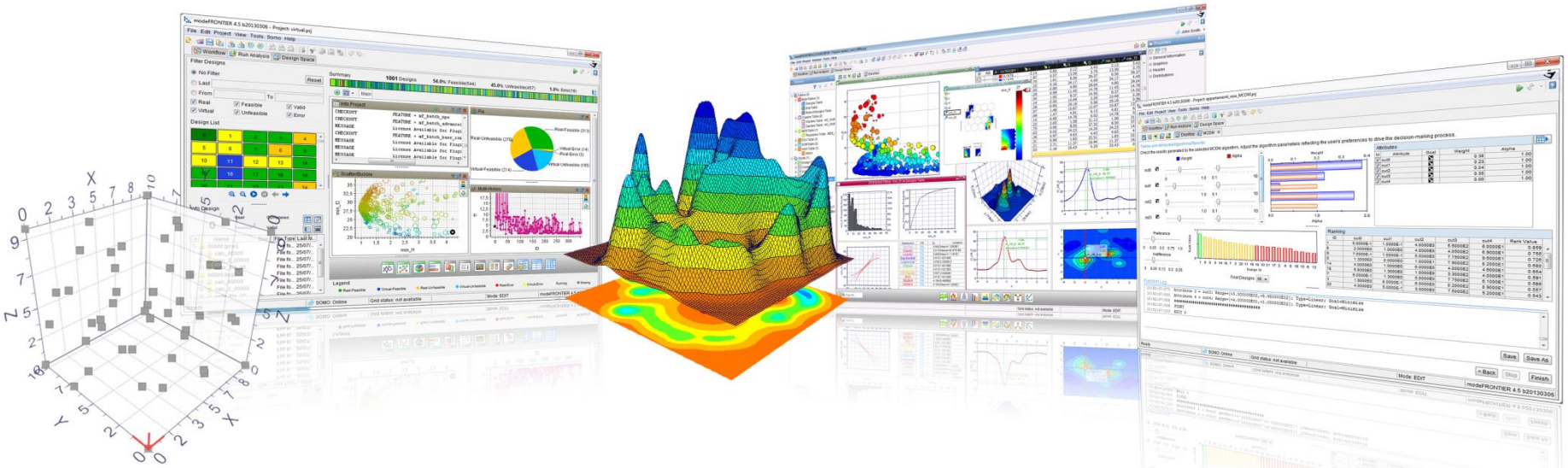
Improved **productivity** & reduced turn-around time of about **90%** in **rear impact tests**

FORD

The **fatigue safety** factor robustly improved by **15%**

BMW

Introducing modeFRONTIER

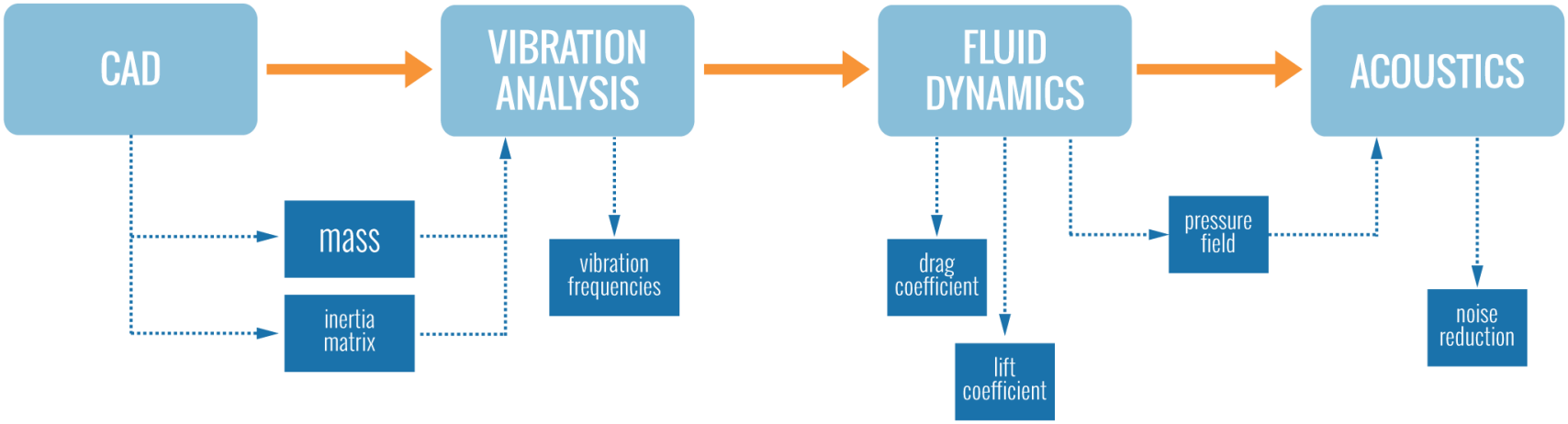


mode FRONTIER

is an integration platform for **multi-objective and multi-disciplinary optimization**. It provides a seamless coupling with third party engineering tools, enables the **automation** of the design simulation process, and facilitates **analytic decision making**.

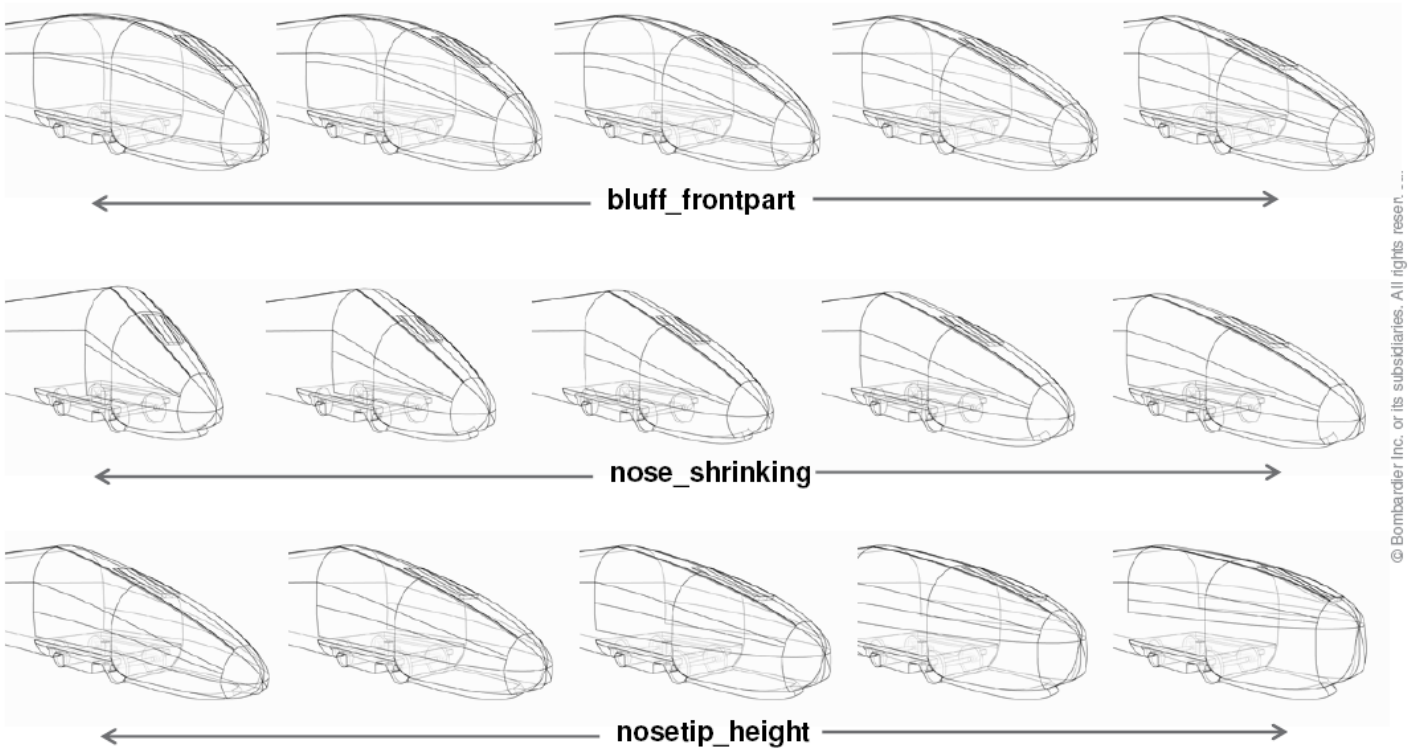
Multi-disciplinary optimization with modeFRONTIER

modeFRONTIER integrates with **any parametric software** (CAD, CAE, FEM, generic, etc.) **automating** the entire optimization process in which data is transferred from one simulation to the next and the relevant values of outputs and objectives are extracted.

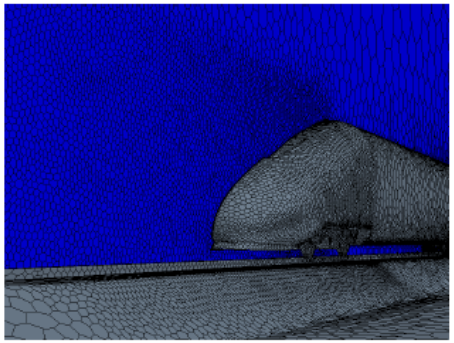


This **multi-disciplinary approach** allows to exploit the **interaction** between the disciplines and determine the **global optimum solution**, instead of optimizing each discipline sequentially.

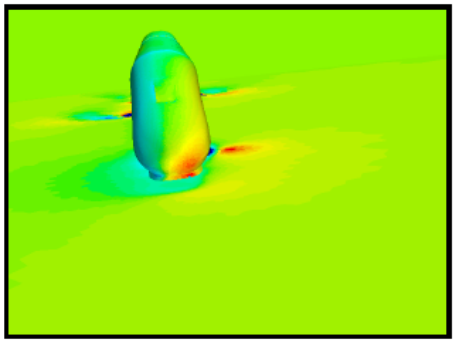
Examples for Model Variability (3 parameters out of 60)



Aerodynamics: Drag and Cross wind stability shape-optimization of a train (courtesy of Bombardier Inc)

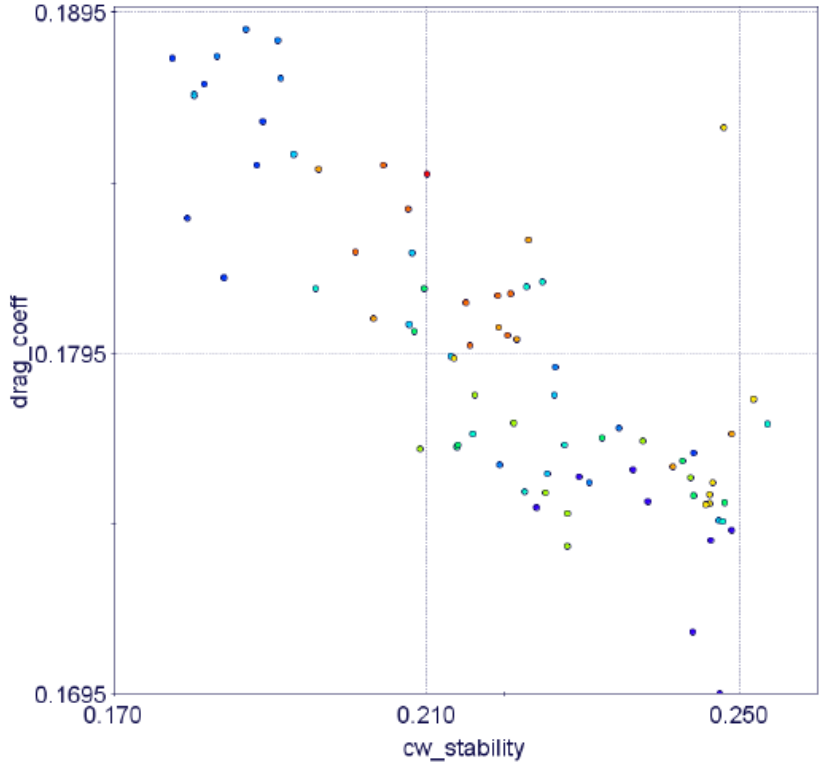


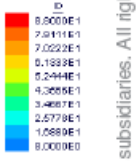
- **Drag**
  - Setup: train cruising with 350 km/h in open field
  - Objective function: drag coefficient
  - Evaluated in CFD code (Star-CCM+)
  - Using a grid of ~700 000 cells
  - ~ 5 h per Iteration on 4 CPUs
  - Optimised with MOGA2

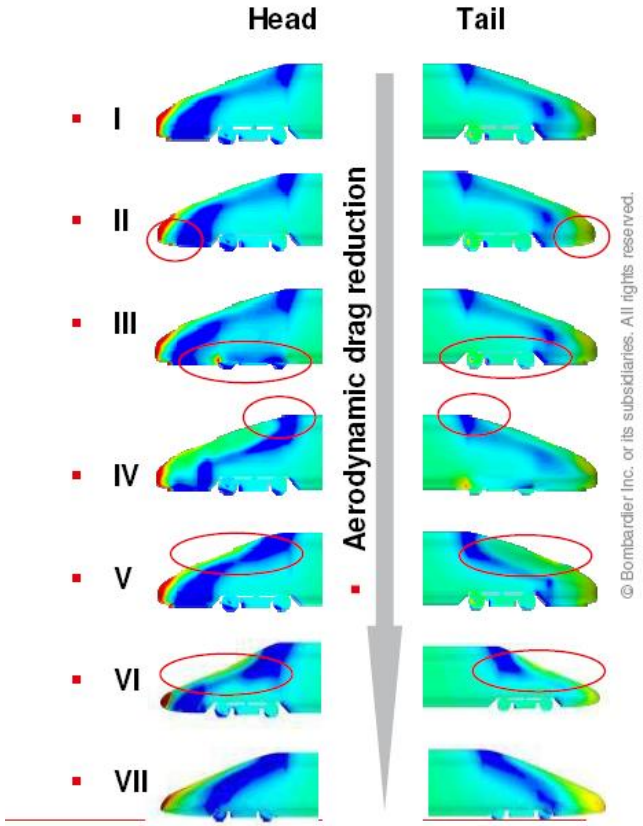


- **Cross-Wind**
  - Setup: train cruising with 300 km/h and a perpendicular crosswind of 109.2 km/h
  - Goal function: Crosswind Stability
  - Evaluated in an inhouse Matlab tool on the base of force coefficients estimated in StarCCM+
  - 700 000 cells, ~ 6 h / iteration

Aerodynamics: Drag and Cross wind stability shape-optimization of a train (courtesy of Bombardier Inc)





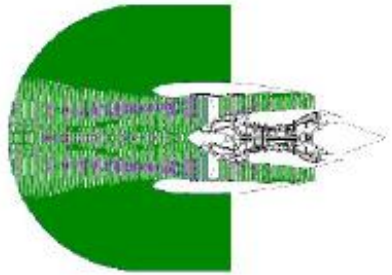


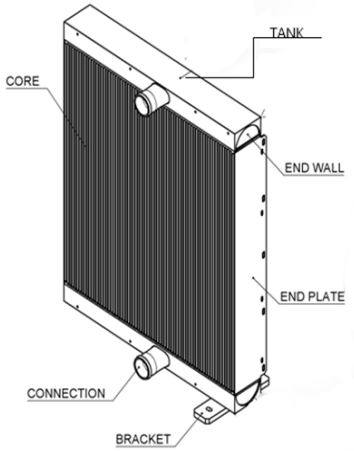
ESTECO and European Projects (last 10 years)

6 **Europeran Projects**

6 **Regional Projects**

- UMRIDA | Uncertainty Management for Robust Industrial Design in Aeronautics
- OptimHEX | Virtual platform for design and optimization of compact Heat Exchangers
- EPES | Eco process engineering system for composition of services to optimize product life cycle
- PICCO - industrial design on cloud computing infrastructure
- DDOS | Drug Discovery and Optimization by Simulation
- MSFK | Made in Italy for Flexible and Sustainable Kitchen
- MULTICUBE | Multi-Objective Design Space Exploration of Multi-Processor SOC Architectures for Embedded Multimedia Applications
- NODESIM-CFD | Non Deterministic Simulation for CFD-based Design Methodologies
- OSARE | Open Source Applications for Research and Engineering
- Integrated simulation of an Internal Combustion Engine
- HISAC | Environmental Friendly High Speed Aircraft
- Methodologies for the simulation and the automated optimization of sailing boats aerodynamics



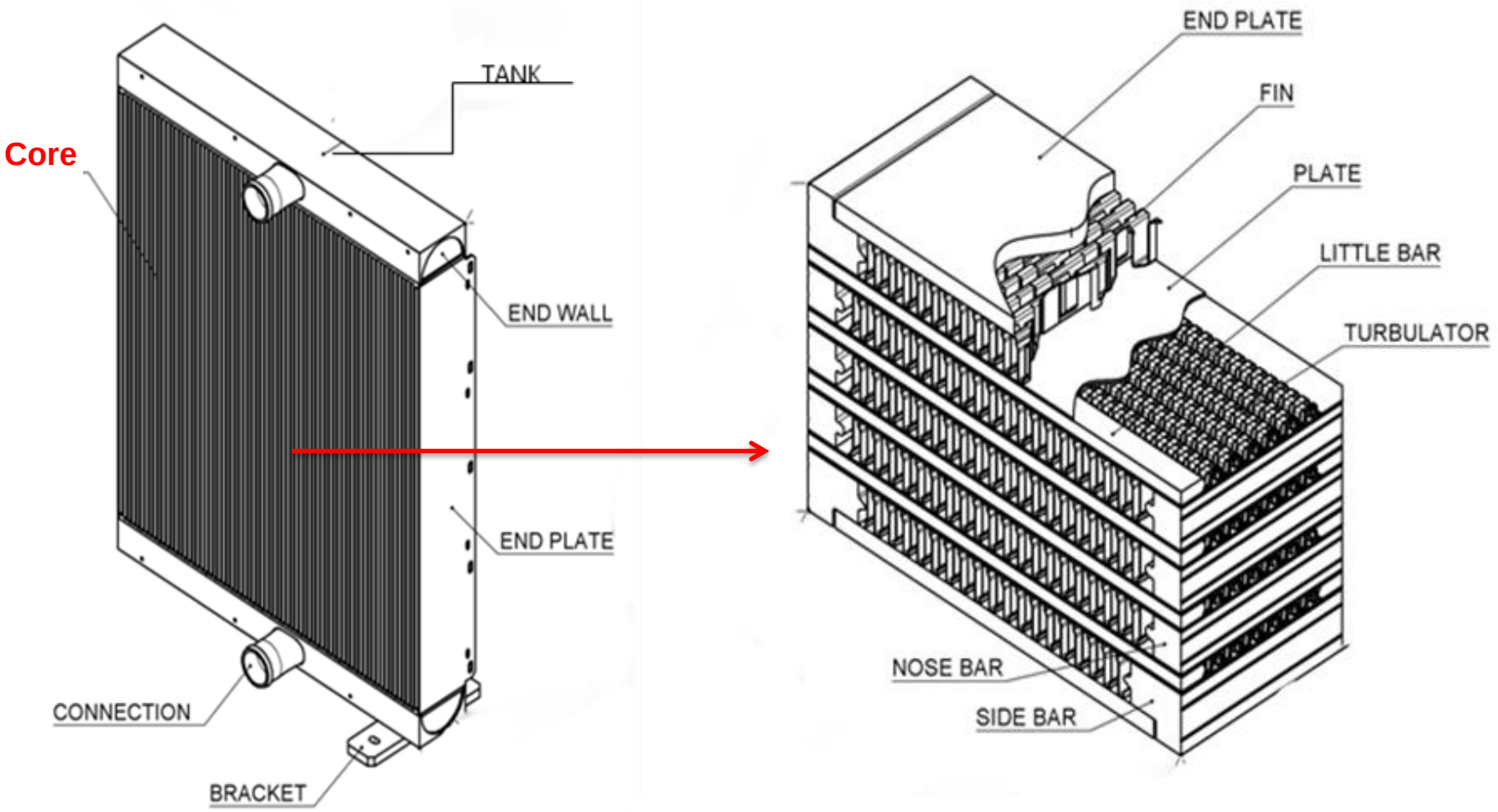


OptimHEX Project

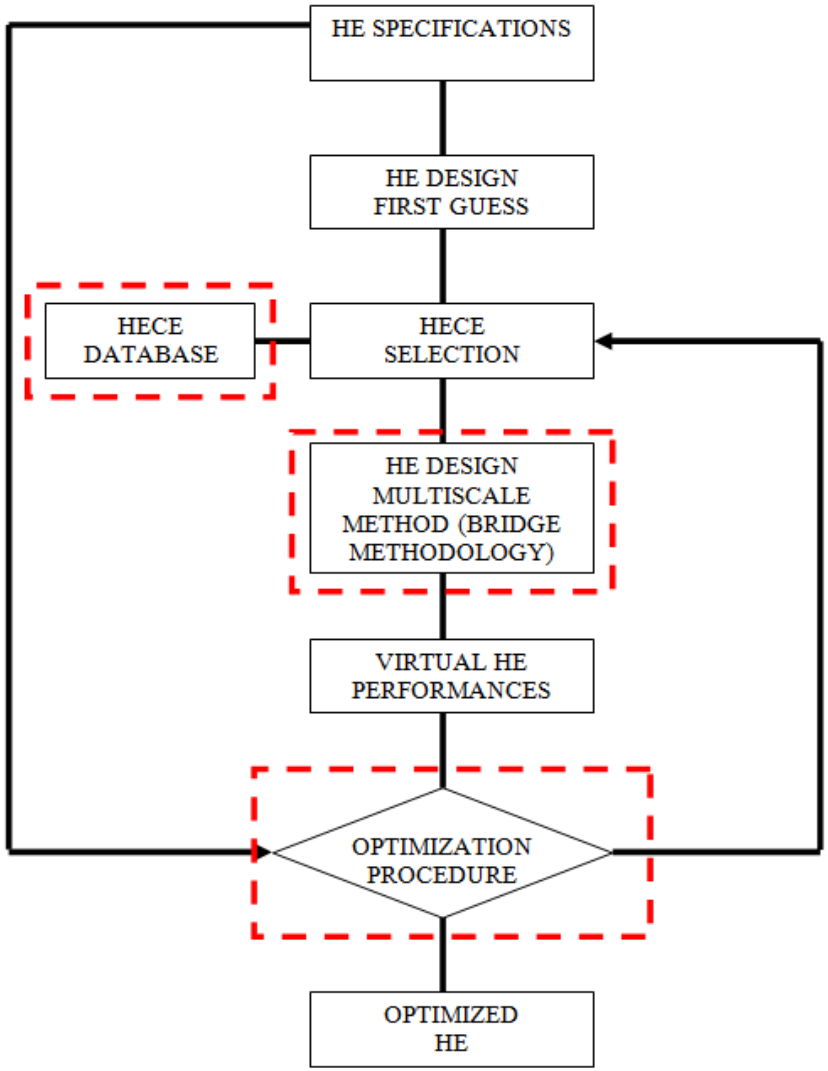
- Funded by Eurostars, powered by EUREKA and the European Community

- Goals:
  - Virtual Heat Exchanger model
  - Methodology for Heat Exchanger design
    - Platform for design optimization that exploits a database of simulation

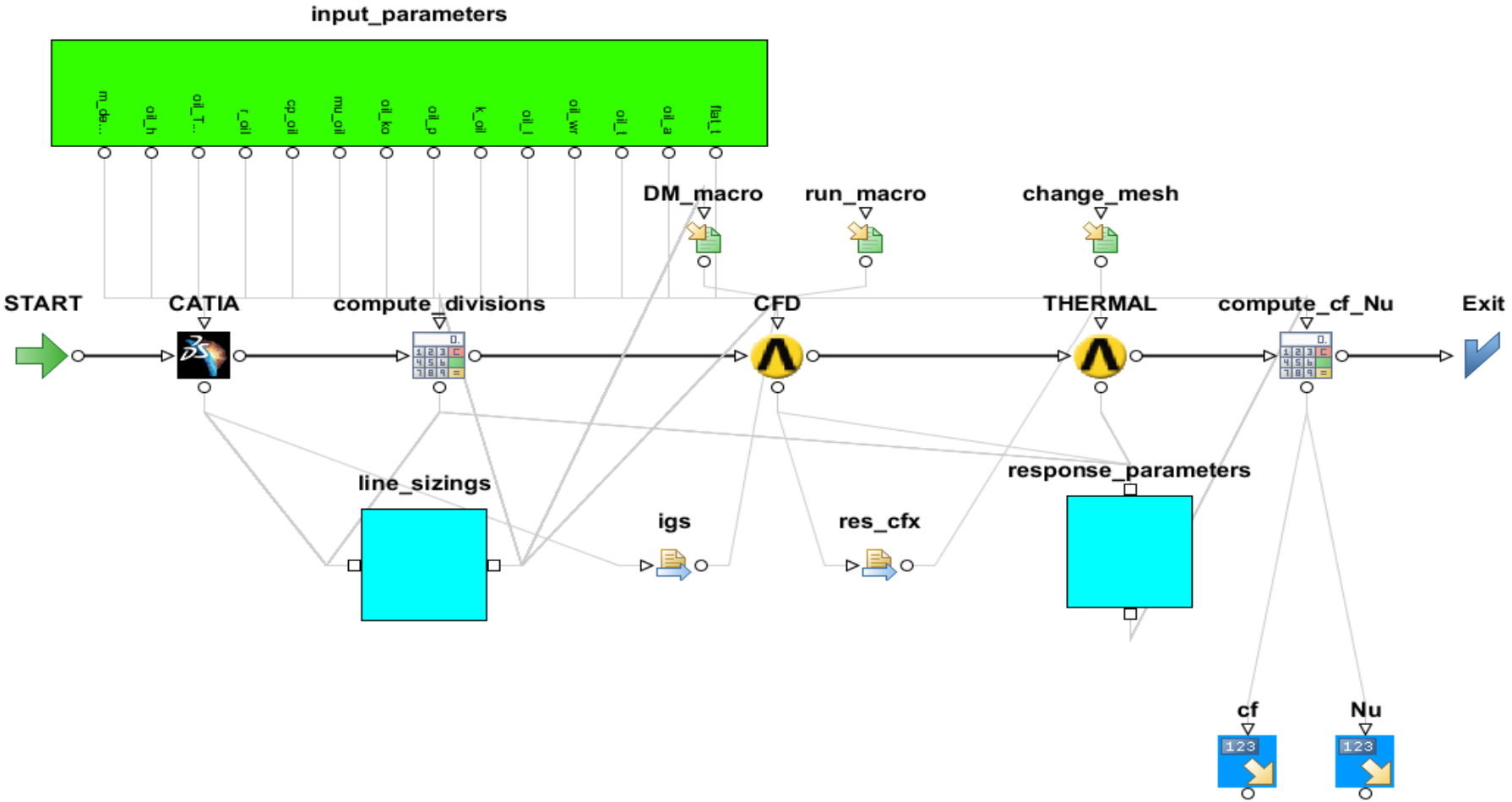
OptimHEX Project: Heat Exchanger



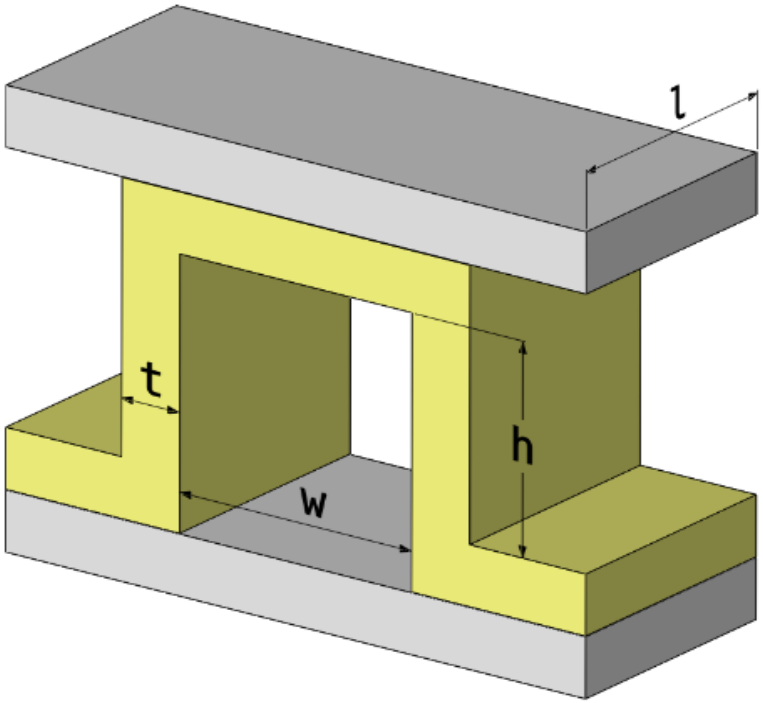
OptimHEX Project: optimization process

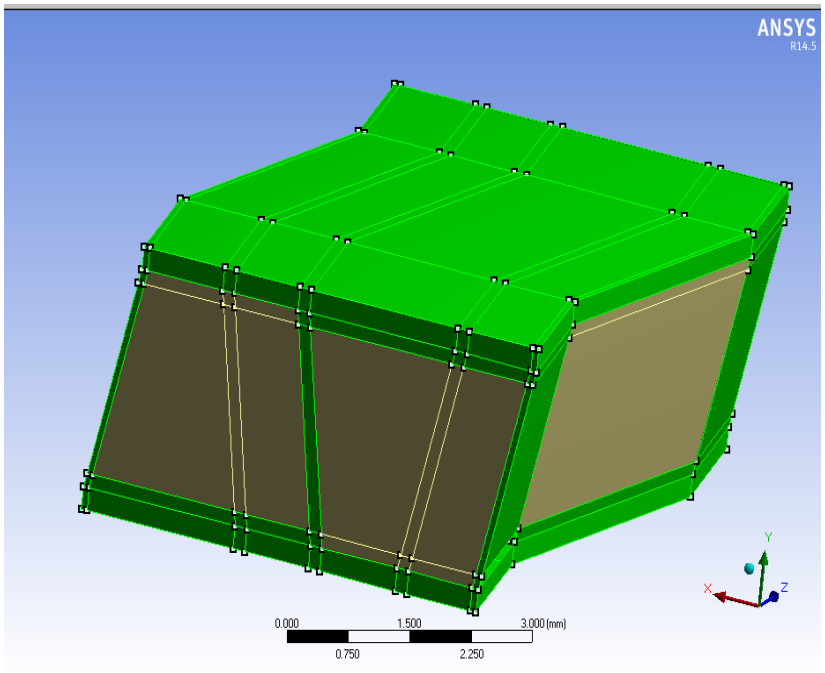


Automation of HECE simulation in modeFRONTIER



HECE: geometrical parameters



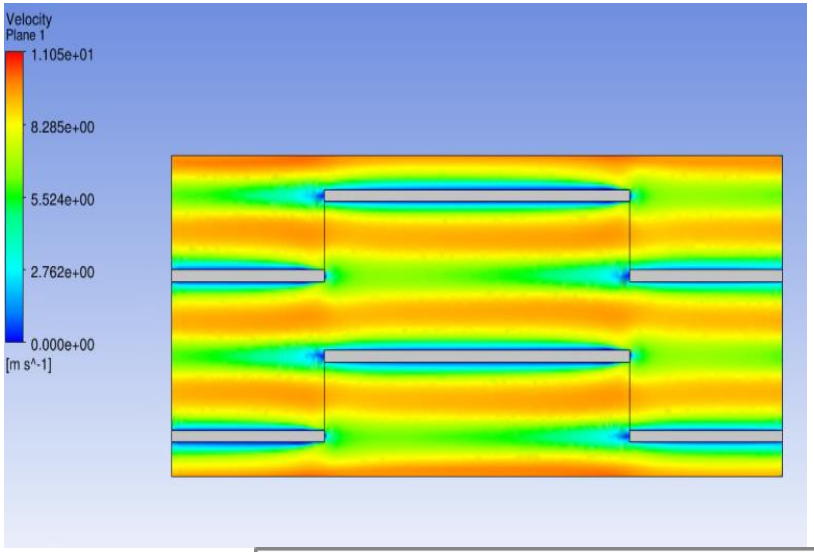


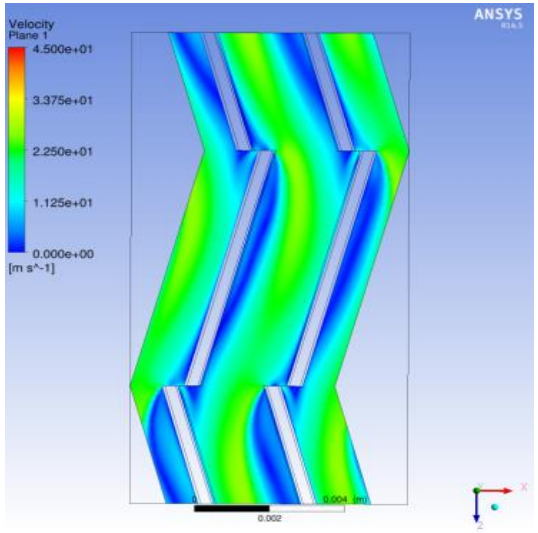
- height *h*
- length *l*
- pitch *w*
- pitch ratio *wr* (ratio between top and bottom pitch, to allow trapezoidal shape of fins besides rectangular ones)
- angle of fins *a* (angle of fins w.r.t. flow direction)
- offset *k* (staggering of two consecutive rows of fins)
- fin thickness *t*.

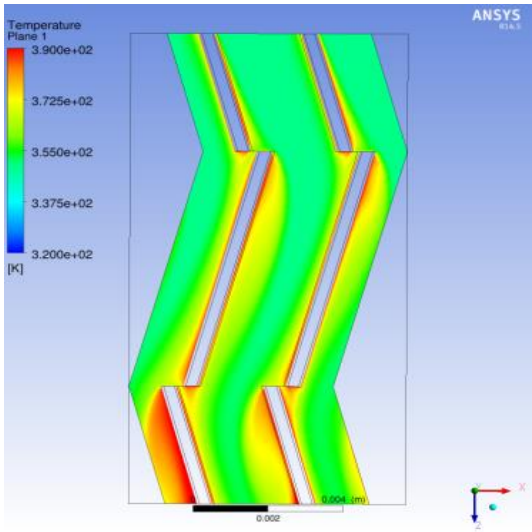
- Automatic meshing blocks update in ANSYS via macro guided by modeFRONTIER

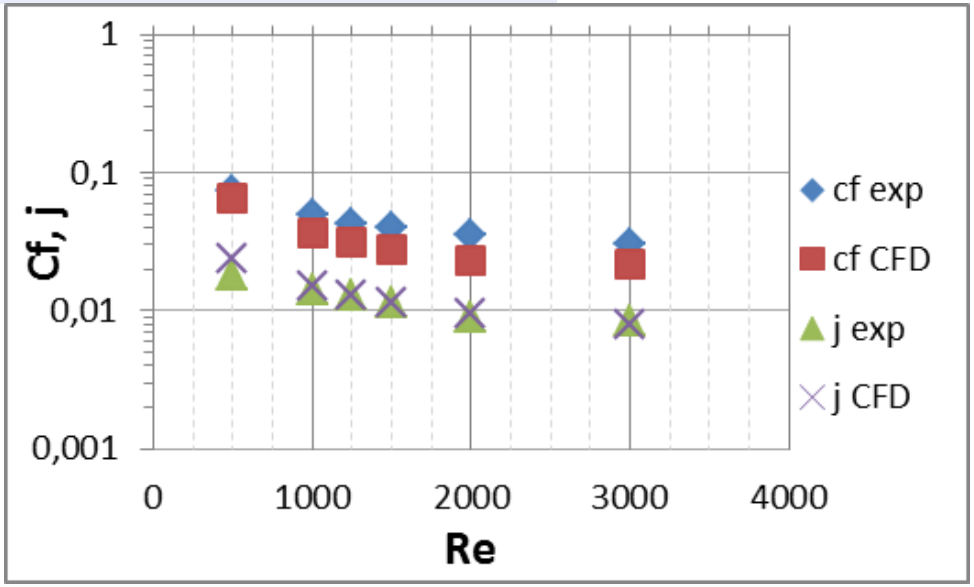
HECE numerical model

- Periodic inlet/outlet with imposed mass flow and constant Heat Flux









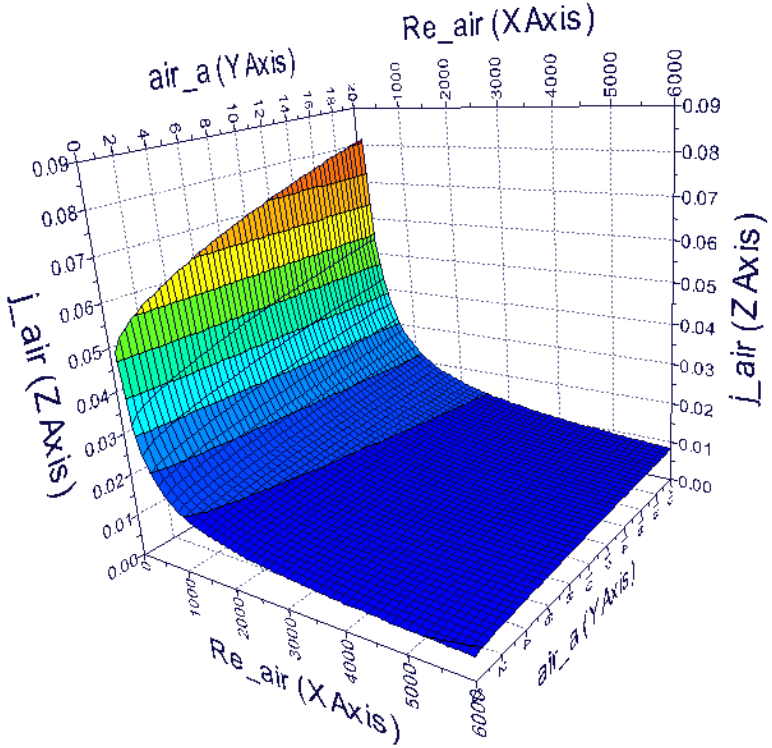
- Good agreement with experimental data (*Kays & London*)

W.M. Kays and A.L. London, Compact heat exchangers Repr. ed. 1998 with corrections.

Response Surface

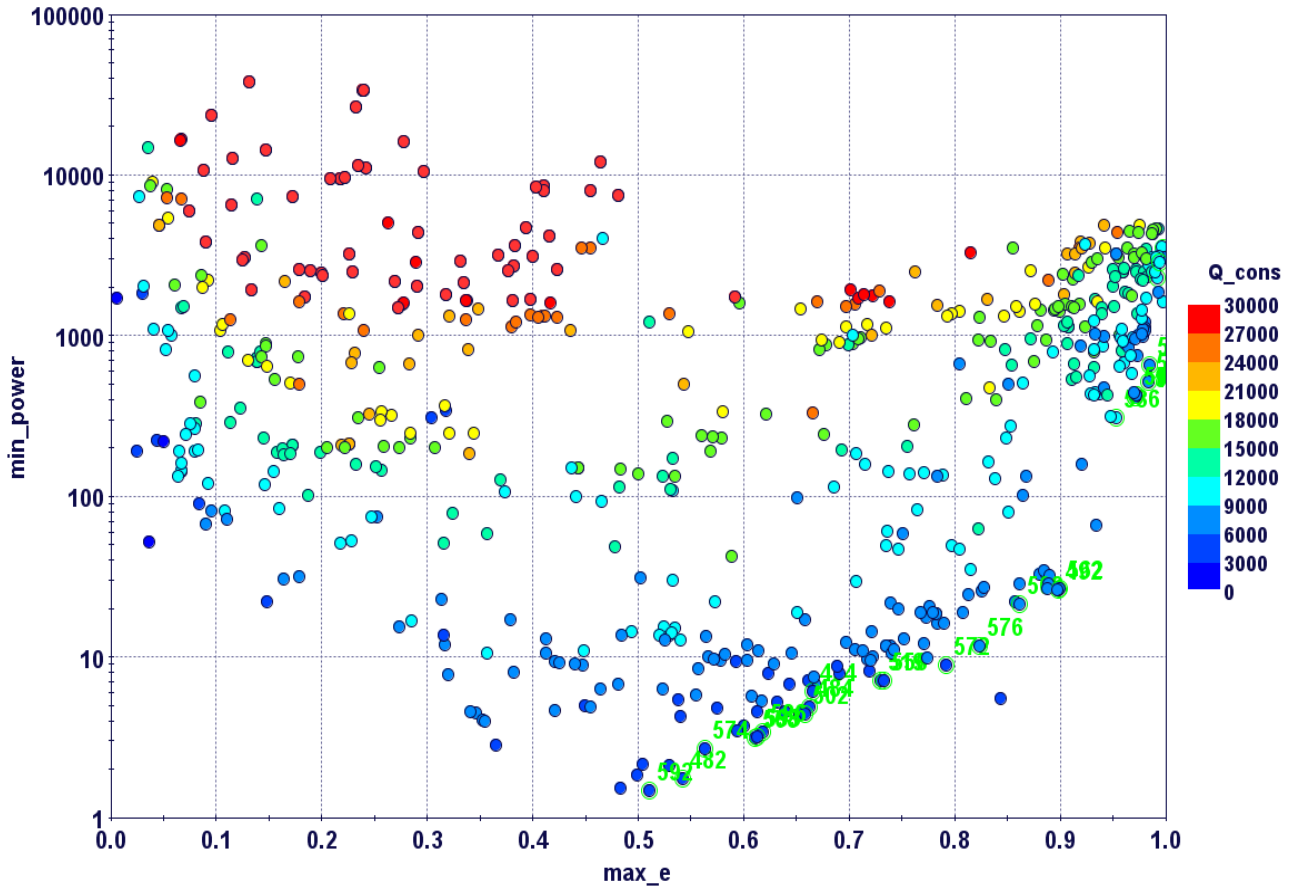
Response Surface Models (RSMs) or metamodels are statistical and numerical models that approximate the input/output behavior of the system under investigation.
Starting from a dataset of real designs, an RSM algorithm guesses the value of the unknown function.

- **Polynomial SVD**
- **Parametric Surfaces**
- **Shepard – K-nearest**
- **Kriging**
- **Radial Basis Functions**
- **Neural Network**



- When HECE simulations database is available, it will be used to train a meta-model to extrapolate HECE performances in function of the input variables.

Optimization example: results



- Maximize HE effectiveness
- Minimize power losses
- Constraint: HE heat exchanged >3KW

- NSGAII with 20 generations
- population size of 30 points
- first DOE by Uniform Latin Hypercube algorithm

Optimization example: results

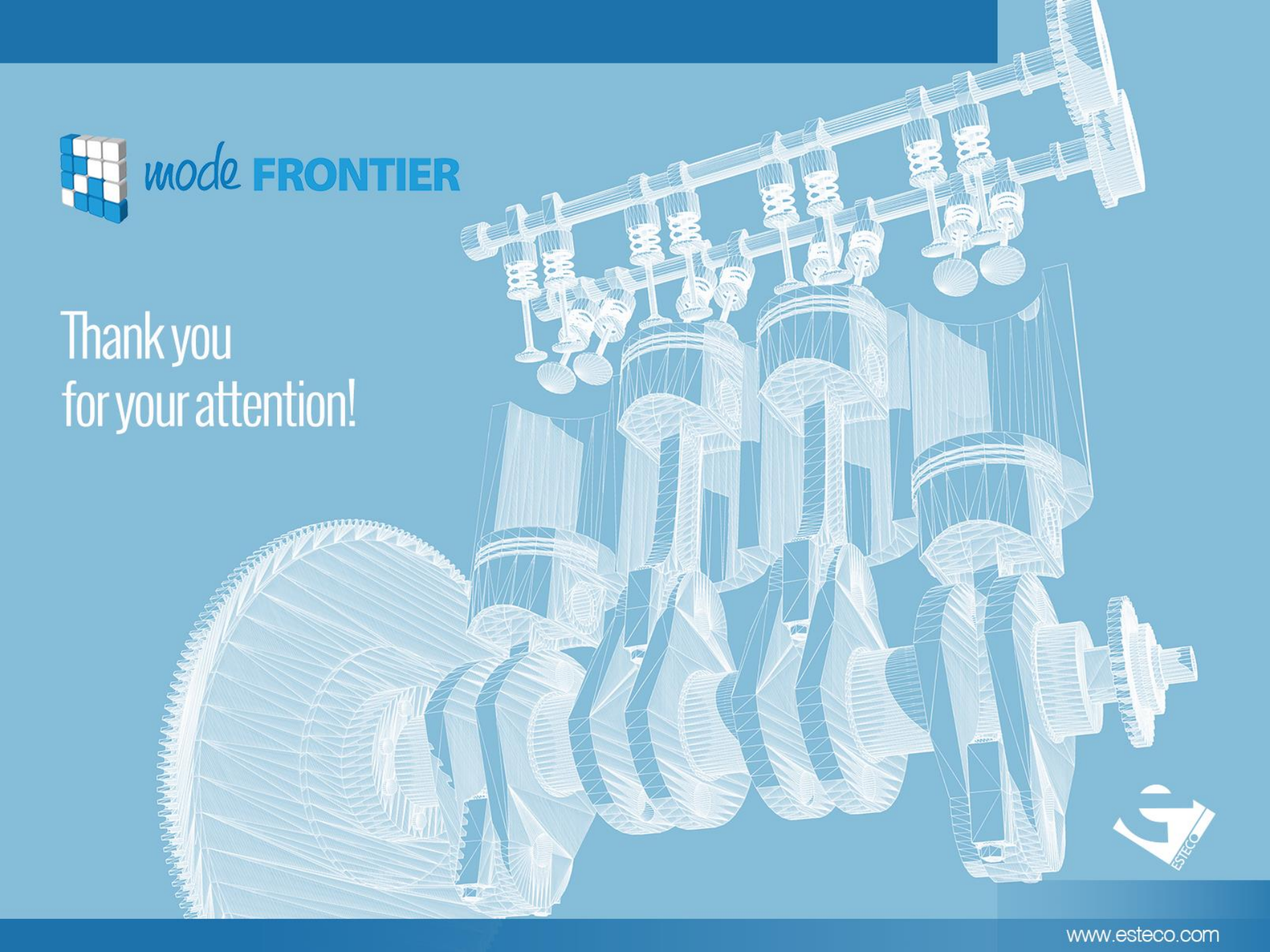
- Effectiveness: 0.994
- Power consumption: 415W
- Heat duty of 3799W

- HE width (oil channel length): 1000 mm
- HE depth (air channel length): 113 mm
- HE height: 388 mm
- air side fins
  - height: 7.75 mm
  - length: 2 mm
  - width: 3.16 mm
- liquid (water-glycol mixture) side fins
  - height: 2.2 mm
  - length: 16 mm
  - width: 2.39 mm
- air mass-flow rate: 2.56 kg/s
- liquid mass-flow rate: 0.0424 kg/s

Conclusion

- The project aims at creating a virtual platform for the optimization of HE, through the usage of modeFRONTIER.

- The next steps of the project are related to the completion of HECE database simulation for the RSM training, and by the experimental prototypization of optimal results to validate the procedure.


mode FRONTIER
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for your attention!
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